Message

From: d'Almeida, Carolyn K. [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=9EC4401AFA1846DD93D52A0DDA973581-CDALMEID]
Sent: 5/1/2015 7:15:31 PM
To: Davis, Eva [Davis.Eva@epa.gov]
Subject: RE: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Oh that one. I have not seen anything go out via email yet. Maybe you addressed their comment.

From: Davis, Eva
Sent: Friday, May 01, 2015 12:08 PM
To: d'Almeida, Carolyn K.
Subject: FW: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

This letter I was wondering about -

From: d'Almeida, Carolyn K.
Sent: Wednesday, April 22, 2015 12:21 PM
To: Wayne Miller
Cc: Davis, Eva
Subject: FW: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Wayne

Eva's comments in red below. Let me know if you want to set up a call to discuss

Carolyn

From: Davis, Eva
Sent: Tuesday, April 21, 2015 1:24 PM
To: d'Almeida, Carolyn K.
Subject: RE: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Carolyn – my responses/comments are in red below – let me know if you want to discuss this. Eva

From: d'Almeida, Carolyn K.
Sent: Tuesday, April 21, 2015 10:49 AM
To: Davis, Eva
Subject: FW: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Eva -- Any comments?

From: Wayne Miller [mailto:Miller.Wayne@azdeq.gov]
Sent: Tuesday, April 21, 2015 8:35 AM
To: d'Almeida, Carolyn K.
Cc: steve
Subject: 2015-4-21 - WAFB - ADEQ comments -work plan to progress report assessment - SEE Contaminant containment issues - ST012

Carolyn – The following is presented to obtain U.S. EPA input.
ADEQ management is concerned that contaminant is not contained. For a lot of years the AF tried to tell us that the plume wasn't moving. But I think finding LNAPL in the RB wells – which were put in in an area that was supposed to be free of LNAPL – clearly showed that the LNAPL and dissolved phase plume were still migrating downgradient. As I said in an earlier email, this thing never has been contained, thus SEE could not have caused a lack of containment. It is clear that the full downgradient extent of LNAPL and dissolved phase plume is not defined. ADEQ management instructed staff and subcontractor review to focus on containment compliance (but not to exclude other issues). My specific directive is to accelerate the downgradient remediation well installation. I won't disagree with that – the sooner they start on the downgradient stuff, the better -

What follows is a DRAFT communication, with ADEQ Contractor comments to be communicated to USAFCEC within the week:

Assessment revealed the following:

General Comments:

ADEQ provided comments to the Air Force by email on 24 February 2015 questioning whether containment of LNAPL and dissolved phase constituents has been achieved during operation of the Steam Enhanced Extraction (SEE) remediation system. The Air Force (AF) responded to the ADEQ comments on 9 March 2015. The responses did not sufficiently address ADEQ's concerns and ADEQ continues to question hydraulic containment based on the data provided in summary format in the SEE system weekly progress reports.

In its March 9 response, AF cites net surplus extraction and the implementation of operation and monitoring approaches described in the RD/RAWP to substantiate hydraulic containment. As described below, these statements alone are inadequate to suggest containment and additional discussion is requested.

The hydraulic containment approach is articulated in the RD/RAWP on p. 4-6:

> *There is a net extraction of groundwater from ST012 during SEE to provide hydraulic containment and groundwater monitoring outside the limits of treatment to verify containment. Injection strategies will be refined during the RD/RA phase to address potential LNAPL migration. Where injection wells bound LNAPL, injections will occur with an outside in approach. Where LNAPL may exist at the perimeter of the treatment zone, initial extraction is anticipated. Monitoring of temperature within and at the perimeter of SEE, groundwater elevations and LNAPL accumulation outside the TTZ, and perimeter groundwater benzene concentrations will be used to demonstrate containment.*

Actual operations have deviated significantly from the operating conditions described in the RD/RAWP (e.g., the groundwater extraction rate has operated well below planned capacities I'm not

readily finding an average predicted extraction rate, but page 19 of TT's Design shows a peak extraction rate of 227 gpm, of which 151 was to come from the LSZ. They have been running at ~ 100 gpm from the LSZ (see figure 17 of the weekly reports). throughout operations while steam injection has often occurred at or near maximum rates according to TT's Design, the peak injection rate for the LSZ was 33,750 lbs/hr, and they were for a time injecting at that rate (see figure 15 of the weekly reports), the injection rate since then has been more like 20,000 lbs/hr average). As a result, the relationship between the observed responses in perimeter monitoring wells, the anticipated responses described in the RD/RAWP, and the effects on hydraulic containment should be documented for each zone and for each of the monitored parameters: groundwater elevations, temperatures, LNAPL measurements, and dissolved benzene concentrations. The only one of these that has not been discussed is dissolved benzene concentrations.

Comments on each of these parameters follow.

1. Net Surplus Extraction

The ratio of mass extraction to mass injection has remained low (~1.5 or less actually figure 18 of the weekly reports shows ~29M gallons extracted and ~12.5M gallons injected, which is a ratio of ~2.3; using the data for the LSZ from figures 14 and 16 shows that for the LSZ the ratio was ~2) compared to the work plan (~2.3) and extraction was halted for a two-week period in late December-early January actually the weekly report (figure 17) shows extraction was cut back during this time period but not halted scaled back to 20 gpm briefly then brought back to the 80 – 100 gpm range while steam injection continued figure 15 of the weekly report shows the steam injection rate cut back to ~5000 lbs/hr for several days before being ramped back up. It is not evident that this lower ratio of mass rates was evaluated for hydraulic containment in the RD/RAWP. The ratio of mass extraction to mass injection at peak flows is described in the RD/RAWP as follows (p. 3-9):

> *The anticipated overall peak liquid extraction rate from the MPE wells is approximately 2.3 times the expected peak steam liquid injection rate.* Cumulative water balance in the weekly report (figure 18) shows ~29M gallons extracted and ~ 12.5M gallons injected – they are right on target

In addition, net surplus extraction on a mass basis is insufficient to demonstrate hydraulic containment. As stated in the RD/RAWP, Appendix D, p 19: agreed

> *Numerical water and energy balance calculations were conducted as part of the design effort to investigate the importance of groundwater flux, water and steam extraction rates, steam injection well spacing and steam injection rates for the temperatures that can be achieved in situ.*

As stated in the RD/RAWP, Appendix D, p 63:

> *Hydraulic control will be verified by ensuring net water removal from the Site and groundwater elevation monitoring outside the TTZs. Liquid removal rates will be set to ensure that liquid extraction is at least 1.5 times the net water injection rate via steam to ensure hydraulic containment of the TTZ.* According to the weekly reports, I believe they have meet this essentially all the time with the exception maybe a brief time when extraction was shut down in late January – early February (see figure 17).

As stated in the RD/RAWP, Appendix E, p 5-14: agreed

Regardless of the level of model sophistication, geological complexity adds a high degree of uncertainty to any prediction that is based on assumed geologic interpretations.

As stated, calculations should be accompanied by an energy balance and include the impact of groundwater flow into the site from natural gradients. What are the current estimates for groundwater fluxes into the individual treatment zones? Please provide the hydraulic containment calculations performed with the lesser mass ratio of 1.5 that includes the natural groundwater gradient and an energy balance.

2. Perimeter Monitoring

As described below, perimeter monitoring data do not lead to a conclusion supporting hydraulic containment..

2a. Perimeter Groundwater Elevation Measurements

The interpretation of groundwater elevation measurements at ST012 during steam injection is very complex. The impact of a growing steam zone, heterogeneous soil layering, and a rising water table on water level readings is not easily assessed. The pressure gradient in a steam zone is different than the pressure gradient in water saturated soil such that some knowledge of the growing steam zone location and volume is desirable. In addition, significant flow through a high permeability interval such as found in the deep LSZ below approximately 230 feet bgs may occur without a measurable change in water level. This interpretation is further confounded by unknown leakage through the overlying low permeability zone and the rising water table. For these reasons, the water level measurements are considered an unreliable indicator of hydraulic containment during steam injection. This is supported by the significant fluctuations in perimeter water levels reported on Figure 22 of the weekly SEE system progress reports. I won't argue with this.

2b. Perimeter Temperature Measurements

Perimeter temperatures are increasing, suggesting a loss of hydraulic containment rather than maintenance and temperature monitoring beyond the boundaries is not available. Examples are provided below.

i). As reported in the Weekly Progress Report from 30 March 2015, temperature arrays were pulled from TMP-7 and TMP-17 and found to be damaged. The timing and nature of the damage was not reported and the previous readings appeared to be functional and reasonable not in the 170 – 225 ft depth range. Hence, at a minimum the data indicated heating at those locations (i.e., reasonable temperature responses) and do not support hydraulic containment. Damage to the temperature arrays would not be expected to yield temperatures deviating from ambient in such a reasonable manner. These TMPs are at the perimeter of the treatment area and I would expected them to show heating.

ii). TMP-7 is located between two extraction wells on the eastern boundary of the TTZ and shows an increasing temperature in the deep LSZ. This deep interval is associated with the higher permeability soils cited above and the increasing temperature indicates the flow of hot water away from the TTZ and argues against hydraulic containment. TMP-7 is within the expected radius of influence of steam injection well LSZ-22 so it is not surprising that steam reached close to this location. The data in the March 25 report shows that only the very bottom of this TMP showed a significant temperature increase (see figure 7) so the loss there is likely not great.

iii). TMP-17 is well outside the UWBZ treatment area yet it has a large temperature response at 190 ft bgs that is not vertically continuous with temperature readings in the LSZ that suggest steam conditions on the boundary of the LSZ. These observations do not support a finding of hydraulic containment. Considering the distance from a UWBZ injection well and the lower all around injection rates in the UWBZ, it may be more likely that this temperature increase is due to steam migrating up from the LSZ – it just didn't come up through the location of the TMP.

iv). Temperature monitoring does not exist at the boundary or beyond at the southwest corner of the LSZ TTZ and therefore no assessment is available from temperature readings for hydraulic containment in this area of the site.

v). Temperature monitoring does not exist at the boundary or beyond on the western boundary of the LSZ TTZ and therefore no assessment is available from temperature readings for hydraulic containment in this area of the site. TMP-3 has shown heating in the UWBZ outside its TTZ boundary. From the shape of the curve, it looks like heat conduction from below.

vi). Temperature monitoring does not exist along the full length of the northern boundaries of either the LSZ or UWBZ TTZs and therefore no assessment is available from temperature readings for hydraulic containment in these areas of the site.

Recently data from thermocouples in the "W" wells surrounding the SEE treatment area was added to the weekly reports as figure 25. This data shows relatively consistent, very slow heating in most of the wells initially, which would indicate that the source of the heating is not the SEE operations, as these wells are varying distances from the SEE treatment area, and from injection wells, and you would not expect them to heat at the same rate due to the SEE system. Also it should be noted that the temperature changes are very slight – around 0.05C. The exceptions are U37 and W37, which more recently have shown greater increases, but still the maximum increase recorded in ~ 6 months is less than 0.2C.

2c. Perimeter LNAPL Measurements

i). In the 9 March 2015 response to ADEQ's comments, the Air Force stated:

> *The observed increases in LNAPL in this well [i.e., ST012-W37] during SEE operations are in response to hydraulic changes in the area that allow LNAPL already in the vicinity to accumulate in the well, similar to observations during the operation of the ST012 containment system before SEE operations commenced. We have also seen similar responses in ST012-W11 recently at a smaller scale.*

What level of LNAPL accumulation in W37 or W11 would indicate loss of hydraulic containment? Can't say – we don't know how much was over there to begin with. If the value cannot be quantified, then this parameter is not applicable to evaluating hydraulic containment. true

ii). In the March 9, 2015 response letter, AF states that LNAPL is migrating "locally within the containment area" based on measured gradients. However, the table embedded within slide 4 of the letter indicates periods when the differential between wells W37 and W24 is either negative or positive, suggesting either an inward or outward gradient.

Following the initial LNAPL increase in well W37 in late December, the LNAPL was removed by bailing and then pumping. LNAPL has continued to move into this well in significant quantities, suggesting that the volume of LNAPL in the area is greater than anticipated. Based on the fluctuating perimeter water levels and the noted changes in the groundwater gradient, the LNAPL boundary near well W37 cannot be known with any certainty. Well W24 is ~ 150 feet to the east (downgradient), has not historically contained LNAPL (according to the 2013 groundwater monitoring report, appendix E), and the current benzene concentrations (less than 1 ppb) do not indicate the nearby presence of LNAPL. so its extent is bounded in the downgradient direction.

The AF should provide additional data to verify the extent of LNAPL contamination, or provide a plan to confirm the extent of the LNAPL boundary east of Sossaman Rd. I am under the impression that a further delineation of LNAPL extent will be done prior to the implementation of the enhanced bio, as this was discussed at one BCT meeting.

2d). Perimeter Dissolved Benzene Concentrations

Dissolved benzene concentrations have definitively increased in five of the eight LSZ perimeter monitoring wells and dramatic increases have been observed in W11 according to the 2013 groundwater monitoring report appendix E, this well has historically had LNAPL in it, W34 , W36, and W37 according to the 2013 groundwater monitoring report appendix E, this well has historically had LNAPL in it. Of the parameters measured in the perimeter monitoring wells, the benzene concentration is considered the most reliable indicator of hydraulic containment. Why? Increasing concentrations are indicative of a loss of hydraulic containment. Not necessarily – as pointed out earlier in your letter there is also a rising water table which may cause increasing concentrations as additional contaminated soils are encountered, and there are considerable fluctuations in the data which may not have anything to do with recent losses in hydraulic containment.

The most recently available analytical data from March 2015 shows benzene at 470 µg/L in well W34 this is somewhat anomalous because other JP4 constituents did not show corresponding increases in concentration, I have already asked Don Smallback to confirm this number but I have not yet had a response and 1,000 µg/L in well W36 the benzene concentration in this well jumped from 6.2 on 10/30/14 to 930 ppb on 11/20/14, however appendix F of the 2013 groundwater monitoring report shows concentrations of 138 ppb in 11/2010, and 362 ppb in

11/2011; it is difficult to determine if this is a natural fluctuation or not. Both of these wells are a significant distance down gradient of the ST012 source area and thermal treatment zones, and the reported COC concentration increases coincide with startup and operation of the SEE.

As a result, additional wells are necessary to determine the full down gradient extent of COC concentrations exceeding ROD cleanup levels. Definitely – but that is not because of the SEE operation.

Specific Comments On Weekly Progress Reports:

1. Energy Balance for Individual Treatment Zones

The water extraction and steam injection are provided for the three individual treatment zones. To aid in assessing progress at the site, please similarly provide separate energy balances and energy balance rates for each of the three zones treated by SEE (i.e., energy injected, energy extracted and energy in the soil).

2. Steam Zone Volume for Individual Treatment Zones

In addition to an energy balance for each zone, please provide an additional graph with an estimate for the steam zone volume in each of the three treatment zones. This plot could also be a logical extension of the Average Temperature presented for each zone.

Thanks.

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